

What is claimed is:

- 1 1. A method of determining placement of components in a rack comprising the  
2 steps of:
  - 3 a. providing a rack height, a set of components, and a height for each  
4 component in the set of components;
  - 5 b. determining a placement of the components in the rack according to  
6 constraints; and
  - 7 c. evaluating the placement of the components according to an objective.
- 1 2. The method of claim 1 wherein the constraints comprise:
  - 2 a. a rack height constraint which requires that placement of a particular  
3 component does not result in a top height of the particular component  
4 exceeding the rack height;
  - 5 b. a single placement constraint which requires that each component be  
6 placed once and only once; and
  - 7 c. a non-overlapping constraint which requires that each slot in the rack be  
8 occupied by no more than a single component.
- 1 3. The method of claim 2 wherein the constraints further comprise a height  
2 preference constraint which prefers that a first component be placed above a  
3 second component.
- 1 4. The method of claim 1 wherein the step of determining placement of the  
2 components according to the constraints finds that at least one of the constraints  
3 cannot be met and further comprising the steps of:
  - 4 a. relaxing a particular constraint; and
  - 5 b. determining placement of the components according to remaining  
6 constraints.
- 1 5. The method of claim 4 wherein the step of relaxing the particular constraint  
2 comprises providing a choice of relaxation constraints to a user and the user  
3 selecting the particular constraint from the choice of relaxation constraints.

1     6.     The method of claim 1 further comprising the step of providing a weight and a  
2     weight distribution for each component in the set of components.

1     7.     The method of claim 6 wherein the step of evaluating the placement of the  
2     components in the rack according to the objective comprises seeking a minimum  
3     height for the center of gravity.

1     8.     The method of claim 6 wherein the step of evaluating the placement of the  
2     components in the rack according to the objective comprises ensuring that a height  
3     of the center of gravity does not exceed a selected height.

1     9.     The method of claim 1 further comprising the step of providing a placement  
2     height range for a particular component, wherein the placement height range  
3     comprises a minimum height and a maximum height.

1     10.    The method of claim 9 wherein the placement height range is increased,  
2     thereby forming an increase in the placement height range, and further wherein a  
3     penalty is applied to the objective according to the increase in the placement  
4     height range.

1     11.    The method of claim 1 further comprising the step of providing an empty  
2     space requirement for a particular component.

1     12.    The method of claim 11 wherein the empty space requirement is selected from  
2     the group consisting of an empty space requirement above the particular  
3     component and an empty space component below the particular component.

1     13.    The method of claim 11 wherein the empty space requirement is relaxed,  
2     thereby forming a relaxation of the empty space requirement, and further wherein  
3     a penalty is applied to the objective according to the relaxation of the empty space  
4     requirement.

- 1 14. The method of claim 1 wherein the steps of determining and evaluating the  
2 placement of the components comprise the step of employing a mixed integer  
3 programming technique.
- 1 15. The method of claim 14 wherein the step of employing the mixed integer  
2 programming technique employs a heuristic approach.
- 1 16. The method of claim 1 further comprising a contiguous placement constraint  
2 for at least two of the components within the set of components.
- 1 17. The method of claim 16 wherein the step of determining the placement of the  
2 components in the rack according to the constraints comprises forming a virtual  
3 component from the at least two components according to the contiguous  
4 placement constraint and further wherein remaining constraints determine  
5 placement of the virtual component.
- 1 18. The method of claim 1 further comprising the step of evaluating the placement  
2 of the components according to a second objective.
- 1 19. The method of claim 1 further comprising the step of evaluating the placement  
2 of the components according to additional objectives.
- 1 20. The method of claim 1 wherein the constraints comprise hard constraints.
- 1 21. The method of claim 1 wherein the objective comprises a soft constraint.
- 1 22. The method of claim 1 wherein the objective comprises a sum of soft  
2 constraints.
- 1 23. A method of determining placement of components in a rack comprising the  
2 steps of:  
3 a. providing a rack height, a set of components, and, for each component in  
4 the set of components, a height, a weight, and a weight distribution;

- 5       b.       determining a placement of the components in the rack according to
- 6               constraints, wherein the constraints comprise:
- 7           i.       a rack height constraint which requires that placement of a particular
- 8               component does not result in a top height of the particular component
- 9               exceeding the rack height;
- 10          ii.       a single placement constraint which requires that each component be
- 11               placed once and only once; and
- 12          iii.       a non-overlapping constraint which requires that each slot in the rack
- 13               be occupied by no more than a single component; and
- 14       c.       evaluating the placement of the components by seeking a minimum height
- 15               for a center of gravity of the components.

- 1   24.    A computer readable memory comprising computer code for directing a
- 2           computer to make a determination of placement of components in a rack, the
- 3           determination of the placement of the components comprising the steps of:
- 4       a.       obtaining a rack height, a set of components, and a height for each
- 5               component in the set of components;
- 6       b.       determining a placement of the components in the rack according to
- 7               constraints; and
- 8       c.       evaluating the placement of the components according to an objective.
  
- 1   25.    The computer readable memory of claim 24 wherein the constraints comprise:
- 2       a.       a rack height constraint which requires that placement of a particular
- 3               component does not result in a top height of the particular component
- 4               exceeding the rack height;
- 5       b.       a single placement constraint which requires that each component be
- 6               placed once and only once; and
- 7       c.       a non-overlapping constraint which requires that each slot in the rack be
- 8               occupied by no more than a single component.
  
- 1   26.    The computer readable memory of claim 24 wherein the step of determining
- 2           placement of the components according to the constraints finds that at least one of
- 3           the constraints cannot be met and further comprising the steps of:
- 4       a.       relaxing a particular constraint; and

5        b.        determining placement of the components according to remaining  
6                constraints.

1    27.    The computer readable memory of claim 26 wherein the step of relaxing the  
2        particular constraint comprises providing a choice of relaxation constraints to a  
3        user and the user selecting the particular constraint from the choice of relaxation  
4        constraints.

1    28.    The computer readable memory of claim 24 further comprising the step of  
2        obtaining a weight and a weight distribution for each component in the set of  
3        components.

1    29.    The computer readable memory of claim 28 wherein the step of evaluating  
2        the placement of the components in the rack according to the objective comprises  
3        seeking a minimum height for the center of gravity.

1    30.    The computer readable memory of claim 28 wherein the step of evaluating the  
2        placement of the components in the rack according to the objective comprises  
3        ensuring that a height of the center of gravity does not exceed a selected height.

1    31.    The computer readable memory of claim 24 wherein the step of evaluating the  
2        placement of the components comprises the step of employing a mixed integer  
3        programming technique.

1    32.    The computer readable memory of claim 31 wherein the step of employing the  
2        mixed integer programming technique employs a heuristic approach.

1    33.    A computer readable memory comprising computer code for directing a  
2        computer to make a determination of placement of components in a rack, the  
3        determination of the placement of the components comprising the steps of:  
4        a.        obtaining a rack height, a set of components, and, for each component in  
5                the set of components, a height, a weight, and a weight distribution;  
6        b.        determining a placement of the components in the rack according to  
7                constraints, wherein the constraints comprise:

- 8           i.       a rack height constraint which requires that placement of a particular
- 9           component does not result in a top height of the particular component
- 10          exceeding the rack height;
- 11          ii.       a single placement constraint which requires that each component be
- 12          placed once and only once; and
- 13          iii.       a non-overlapping constraint which requires that each slot in the rack
- 14          be occupied by no more than a single component; and
- 15       c.       evaluating the placement of the components by seeking a minimum height
- 16          for a center of gravity of the components.